

Wind Energy Systems Sound Measurement Worksheet

Source Property _____

Receiving Property _____

Nature of Sound _____

Location of instruments _____

Wind Speed and Direction _____

Equipment _____

___ Residential	___ Nonresidential	___ Industrial
___ Residential	___ Nonresidential	___ Industrial

Date:
Time:
Examiner:

Calibration Check:

Sound level with calibrator in place:

Before	Cal. Level	After
_____ dB	94.0 dB	_____ dB

Measured Sound Levels:

1 **Total Sound Level** (source on):

(C-weighted measurements for low frequencies)

2 **Ambient Sound Level** (quiescent level with source off):

3 **Correction** for the ambient background sound

3a. Enter the difference between line 1 and 2:

3b. If Line 3a = 0 or 1 dB the source level cannot be determined.

= 2 dB → enter 4 dB; = 3 dB → enter 3 dB

= 4-5 dB → enter 2 dB; = 6-9 dB → enter 1 dB

= 10 dB or more → enter 0 dB

4 **Source Sound Level** (line 1 minus line 3b):

5 **Adverse Character** (circle one below):

If low frequency (bass), modulating (swishing) or tonal (humming) → enter 5 dB

6 **Effective Source Level** (line 4 plus line 5):

7 **Increase Above Ambient** (A-wtd level in line 4 minus A-wtd level in line 2)

8 **Low Frequency, $C_{\text{source}} - A_{\text{ambient}}$** (C-wtd level of line 4 minus A-wtd level of line 2)

Sample 1	Sample 2	Average
dB(A)	dB(A)	dB(A)
dB(C)	dB(C)	dB(C)
dB(A)	dB(A)	dB(A)
dB(C)	dB(C)	dB(C)

dB(C)	dB(A)
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dB(C)	dB(A)
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dB(C)	dB(A)
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dB(A)

dB(A)

dB(A)

dB

Sound Limits (dB) on Receiving Properties:

	Industrial	Nonresidential	Residential Day / Night
Effective Source Level (A-wtd) - Line 6	65	60	55 / 45
Increase Above Ambient (A-wtd) - Line 7			5
Low Frequency ($C_{\text{source}} - A_{\text{ambient}}$) - Line 8		20	20

Wind Energy Systems Sound Measurement Worksheet Instructions

Wind Energy Task Force of Lake County Communities

The **Environmental Sound Measurement Worksheet** is intended to determine the average sound level (i.e. **Effective Source Sound Level**) from operating Wind Energy Systems (WES) by correcting for the ambient sound levels and adjusting for adverse characteristics. This measurement will determine whether the sound exceeds the limits stipulated in the ordinance of Lake County or the appropriate municipality.

Sound Level Meters (SLM) must meet the Type 2 grade or better per the latest revision of ANSI S1.4 *American National Standard Specification for Sound Level Meters* and must have an integrating feature that meets ANSI S1.43 *American National Standard Specifications for Integrating Averaging Sound Level Meters*.

The **procedures** outlined here are based in essence on applicable portions of ANSI S12.9 *American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound* and Part 910 of Title 35: Environmental Protection, Subtitle H: Noise, Chapter 1: Illinois Pollution Control Board.

Frequency measurement

- The A-weighted scale is most often utilized for the measurement of tonal or audible sound levels. These are sounds that range from 20 to 20,000 Hz. and that the human ear can typically hear.
- The C-weighted scale is utilized especially for measurement of low frequency sound, i.e. more bass tones or infrasound, which may or may not be audible to the human ear. Low frequency sounds can travel farther and may be enhanced in different locations such as in buildings.

Instrumentation Set-up:

- Ensure the battery is in good condition.
- Measurements may be taken at any position within neighboring property, provided the location is not within:
 - 5 feet of small surfaces (e.g., trees, posts, etc),
 - 25 feet of a large reflective surface (e.g., shed, building, etc), or
 - 50 feet of a large reflective surface if the sound is tonal in nature.
- A tripod for the microphone or SLM is required if the sound is high-pitched. If the sound is low frequency in nature, a hand-held meter is acceptable as long as the arm is extended.
- The microphone on the SLM must be aimed toward the noise source and oriented at an angle recommended by the manufacturer (usually 45-70° off the ground).

Sound Level Limit Regulations for Wind Energy Systems (WES):

- The average sound level from a WES shall not exceed fifty-five (55) dB(A) during daytime hours or forty-five (45) dB(A) during nighttime hours at any point within neighboring, residentially zoned or used property. For neighboring industrial properties the sound level limit is sixty-five (65) dB(A) and for other neighboring nonresidential properties, the sound level limit is sixty (60) dB(A) at any time of the day.
- Five (5) dB shall be added to the average sound level from a WES as a penalty when its sound emissions have an adverse character that includes prominent tones (e.g., a humming sound) or an amplitude fluctuation in synchronicity with the blade revolution (e.g., a periodic swishing sound).
- No WES shall operate with an average sound level more than 5 dB(A) above the non-operational ambient level, as measured within any neighboring residentially zoned or used property, not including the penalty for adverse character.
- To limit the level of low-frequency sound, the average C-weighted sound level during WES operation shall not exceed the A-weighted ambient sound level by more than twenty (20) dB.

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WORKSHEET INSTRUCTIONS

Source and Receiver Location:

Identify the types of property from which the sound is coming (Source) and on which the sound is being measured (Receiver).

Nature of Sound:

Identify what is the Source of the sound being measured.

Weather Conditions:

- Measurements should not be made when ground level winds exceed 10 mph.
- Use an anemometer and compass to measure **wind speed** and **direction** and identify them on the Worksheet.
- Use a thermometer to determine **temperature** and a hygrometer to measure **relative humidity** to identify any adverse conditions. All instruments must be used in accordance with the manufacturer's recommended procedures.
- As an alternative, weather conditions can be obtained from an airport or weather station reporting local conditions through an internet site such as WeatherBug.com.

Equipment:

Identify the type of sound level meter being used and whether measurements will be using the A-weighted scale to measure tonal or audible sound (20 to 20,000 Hz) or the C-weighted scale to measure low frequency sound (Below 200 Hz).

Calibration Check:

Place the calibrator on the SLM microphone and adjust the meter as necessary so that it displays the rated output of the calibrator (usually 94.0 dB). This must be repeated before and after each series of measurements to ensure SLM stability.

Measured Sound Levels:

1. **Total Sound Level:** Collect a 1-2 minute sample of the sound with the Wind Energy Systems operating. Wait over one minute collect a 2nd sample. If the samples are within 2 dB, there is repeatability and the two levels can be averaged for a total sound level. If there is more than a 2 dB difference, repeated samples should be taken to determine which levels are most in common and can be averaged. This is repeated for both the C and A scales.
2. **Ambient Sound Level:** Ambient Sound represents the background sound level observed when the source is not operating. Collect a 10-15 second sample of the Ambient Sound during a quiescent period, that is, a period when there are no nearby distinct or prominent sounds, such as dogs barking, a plane flying over, or a car passing by. Wait over one minute to collect a 2nd sample. If the samples are within 2 dB, there is repeatability and the two levels can be averaged. This is repeated for both the C and A scales.
3. **Correction:** This figure calculates how to correct the Total Sound Level measurement for Ambient Sound.
 - a. Enter the difference between the Total and Ambient Sound Levels [Line 1 – Line 2]

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- b. If the Ambient sound is not at least 2 dB lower than the Total Level on 3a, a determination of violation cannot be made. If the difference is 2 dB enter a “4”; for a difference of 3, enter a “3”; for a difference of 4-5, enter a “2”; for a difference of 6-9, enter a “1”; and for a difference of 10 or more, enter a “0.”
4. **Source Sound Level:** The average sound level from the operating Wind Energy System (Source) is the Total Sound Level minus the Correction factor. [Line 4 = Line 1 – Line 3b]

Adjustments for Character:

5. **Adverse Character:** While sound level is an important aspect of the degree of annoyance of a noise, an adverse character can make the noise especially annoying. Such characters include continuous low frequency (bass), modulating (swishing), or tonal (humming) sounds. If any of these characteristic sounds is clearly audible, then add 5 dB to Line 5.

Effective Source Sound Level:

6. **Effective Source Sound Level** takes into account the corrections for Adverse Character from the sound source. This is the level used to assess compliance with the noise ordinance. [Line 6 = Line 4 + Line 5]

Increase above Ambient Sound Level:

7. An A-weighted sound level from a sound source that is more than 5 dB above the ambient level represents a significant increase in noise and is an objective indicator of annoyance. This is the difference between Line 4 and Line 2 and is used to assess compliance with the noise ordinance on residential properties.

Low Frequency Measurement (if indicated):

8. A C-weighted sound level with the turbine(s) operating that is more than 20 dB above the A-weighted ambient sound level is an objective indicator of annoyance due to a significant increase in low frequency noise. This is the difference between the C-weighted level of Line 4 and the A-weighted level of Line 2 and is used to assess compliance with the noise ordinance.